

Three new species of the genus *Oreophryne* from western Papua, Indonesia

(Amphibia, Anura, Microhylidae)

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On the basis of recently collected specimens and bioacoustic data three new and partly syntopic species of the genus *Oreophryne* (Microhylidae) are described from the Wondiwoi Mountains at the base of the Wandammen Peninsula (Cenderawasih Bay, north-western New Guinea). Two of them belong to a species group whose procoracoid does not extend to the scapula. Males reach 23 mm snout-urostyle length in one species, 29 mm in the other. They differ clearly in coloration, advertisement calls and heights of their perching sites. The procoracoid in the third new species is connected to the scapula by a cartilaginous bridge. This species is one of the smallest of the genus (males to 21 mm). It has a markedly warty skin and its advertisement calls are series of rattled notes, in contrast to series of whistling notes in the former two species. All three species are scansorial. The largest species prefers perches between 2 and 6 m high and males of the two smaller species were mainly found on leaves 0.5 to 2 m above the ground.

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Introduction

In the most recent check list of amphibian species of the world (Frost 2002) nearly 30 species of the genus *Oreophryne* Boettger, 1895 are recognised. About $\frac{2}{3}$ of them occur on the main island of New Guinea and/or on nearby islands. Most of these species were described between the years 1878 and 1956. One species was recently described by Richards & Iskandar (2000) and two others by Günther et al. (2001), all three from Irian Jaya (the western part of New Guinea was named West Irian until the middle of the 20th century, then Irian Jaya, Papua Barat or West Papua and its official name now is Papua) in the western part of New Guinea. Richards & Iskandar (2000) and Günther et al. (2001) pointed out that a large number of additional *Oreophryne* species await description. During field work at the base of the Wandammen Peninsula (Cenderawasih Bay) the author found *Oreophryne atrigularis*, previously de-

scribed in this journal (Günther et al. 2001), and another three new species which are described here.

Material and methods

Most of the specimens were collected at night after locating them by their advertisement calls. Photographs of various individuals were taken the next day. Thereafter they were anaesthetised with chlorobutanol, injected with 5% formalin and stored in 2% formalin. Samples of muscle tissue were taken from the thigh of some frogs and stored in 75% ethanol for later DNA sequencing; then these frogs were also stored in 2% formalin. All specimens were finally transferred to 75% ethanol in the museum collection. The following material was examined for comparative purposes: *Oreophryne kampeni*, BMNH 1947.2.12.14 formerly 97.12.10.143 (holotype); *Oreophryne crucifera*, ZMA 5819 (syntype); *O. albopunctata*, ZMA 5821-22 (syntypes); *O. flava*, ZMA 5823 (holotype) and AMNH 58152-53, 58155-57; *O. insulana*, AMNH 56732, 57265-66; *O. biroi*, NMW 19825:1-4; *Oreophryne*

(*Mehelyia*) *affinis* (considered as a synonym of *O. biroi* by Parker 1934), NMW 19826; *Oreophryne* (*Cophixalus*) *geislerorum*, SMF 4197 (holotype); *O. senckenbergiana* (considered as a synonym of *O. moluccensis* by Parker 1934), SMF 4203 (lectotype).

The following measurements (in mm) were made with Vernier callipers (>10 mm) or with an ocular micrometer in a binocular dissecting microscope (<10 mm):

- SUL, snout-urostyle length from tip of snout to distal end of urostyle bone;
TL, tibia length;
TaL, length of tarsus;
T4L, length of 4th toe from tip of 4th toe to proximal end of inner metatarsal tubercle;
F3L, length of 3rd finger from tip of 3rd finger to proximal end of inner metacarpal tubercle;
F3D, transversal diameter of the disc of 3rd finger;
T4D, transversal diameter of the disc of 4th toe;
T1L, length of first toe distal of the inner metatarsal tubercle;
MTL, length of the inner metatarsal tubercle (callus intertus);
HL, head length from tip of snout to posterior margin of tympanum;
HW, head width taken in the region of tympana;
SL, snout length from tip of snout to an imaginary line connecting centres of the eyes;
END, distance from anterior corner of orbital opening to center of naris;
IND, internarial distance between centres of nares;
ED, eye diameter from anterior to posterior corner of orbital opening;
TyD, horizontal diameter of tympanum;
GFD, distance between glandular folds taken immediately behind eyes.

Some paratypes were cleared and double-stained using a method modified from Dingerkus & Uhler (1977) to assess their generic allocation. From one of the new species only three specimens were obtained. Radiographs of these as well as a superficial dissection of the sternal region followed by cartilage staining in one of the specimens allowed an examination of ventral elements of the pectoral girdle and demonstrated that these specimens belong to the genus *Oreophryne*.

Advertisement calls were recorded with a Sony Digital Audio Tape (DAT) Walkman TCD-D100 and a Senheiser microphone MKE 300 in the field. Calls were analysed with Avisoft-SAS Lab software. All specimens were given preliminary registration numbers of the Institute of Systematic Zoology, formerly Zoologisches Museum, of the Humboldt-University Berlin (ZMB). According to recommendations by Lembaga Ilmu Pengetahuan Indonesia (LIPI) part of the material will be transferred to the Museum Zoologicum Bogoriense, Bogor (MZB), and, if proper conditions can be established, to a museum in Papua as well. All colour photographs were taken by R. Günther, drawings in Figs 3, 7 and 15 were made by Nils Hoff and those in Figs 5, 11 and 16 by Vera Heinrich (both Berlin).

Abbreviations: AMNH, American Museum of Natural History, New York; NMW, Naturhistorisches Museum Wien; SMF, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt/Main; ZMA, Zoologisch Museum Amsterdam.

Oreophryne sibilans, spec. nov.

Figs 1-6

Types. Holotype: adult ♂ (Fig. 1 and 2), collected by R. Günther and G. Mareku on 7.V.2000 at an altitude of 620 m a.s.l., Wondiwoi Mts. at the base of the Wandammen Peninsula, about 8 km west of the coastal village of Yeretuar, 2°56'S, 134°38'E, Papua, Province of Indonesia (ZMB 62587). – Paratypes: 15 adult ♂♂, (ZMB 62368-71, 62373-83), 2 adult ♀♀ (ZMB 62367, 62372), 1 juvenile specimen (ZMB 62384), all collected between 22nd and 29th of August 1999; 1 ♀ (ZMB 62586) (Fig. 3), collected on 7.V.2000 and 1 ♂ (ZMB 62531), cleared and stained as a skeletal preparation. All paratypes were collected between 500 and 700 m a.s.l. on slopes and in valleys east of the main ridge of the Wondiwoi Mts. near the locality of the holotype. Collectors were R. Günther, M. Kapisa, S. Marani and G. Mareku (in alphabetical order).

Diagnosis. *O. sibilans* belongs to the group of smaller species (males smaller than 23 mm SUL and females smaller than 26 mm SUL), whose cartilaginous procoracoid does not extend to the scapula. Its fifth toe is somewhat longer than the third one and there are basal webs between the toes (only scarcely visible between first and second toe). Snout feebly protruding, tympanum not or scarcely recognisable. Dorsal surface greyish or brownish with darker and lighter spots, ventral surface strongly dark brown mottled. Advertisement calls consist of series of peeping or whistling notes, each note from 36 to 59 milliseconds in length, note repetition rate is 6.7/s.

Description of holotype

An adult male with following measurements (in mm) and ratios: SUL 22.0, TL 10.0, TaL 6.6, L4T 9.5, L3F 5.8, F3D 1.6, T4D 1.3, T1L 2.0, MTL 1.0, HL 6.3, HW 7.3, END 1.8, Ind 1.8, ED 2.5, SL 2.9, TyD 1.0, GFD 6.0; TL/SUL 0.45, TaL/SUL 0.30, T4D/SUL 0.0590, T4D/F3D 0.812, HL/SUL 0.286, HL/HW 0.863, END/IND 1.0, ED/SUL 0.113, TyD/ED 0.40, SL/SUL 0.132 and GFD/SUL 0.27. Snout tip blunt and feebly protruding, canthus rostralis roundish, nostrils near tip of snout, tongue rather broad, oval and free posteriorly, denticles of the dermal ridge across the palate in front of the pharynx with blunt tips, postchoanal region with a slightly raised ridge, a long slit on both sides of the tongue marks the entry to a subgular vocal sac; head broader than long; tympanum very indistinct, less than half the size of the eye. Fingers with large discs, that of third

finger broader than half the width of eye; length of fingers 3>2=4>1. Toe discs smaller than finger tips, basal webbing between all toes, very minute between toe 1 and 2, length of toes 4>3>5>2>1 on the left foot, toe 5 is longer than 3 on right foot; subarticular tubercles on hands and feet as well as metatarsal tubercle feebly developed, no outer metatarsal tubercle; a weak supratympanic fold, skin of the whole body smooth (some pustules on dorsum were more clearly visible in life). Dorsal surface of head, extremities and trunk was light grey with smaller and larger dark and some whitish spots in life. Conspicuous blackish spots are above tympanum, on each side of the lumbar region, and commencing between eyes and reaching to the shoulder region. The latter was confined anteriorly by a whitish crossbar and posteriorly by a w-shaped mark in the shoulder region. A large semicircular ocellar spot in lumbar region, and a small whitish spot in the middle of the upper surface of the tibia. Ventral surface everywhere uniformly grey and densely mottled with dark brown. The whole dorsal surface became darker in fixative, two broad dark stripes which diverge posteriorly, not visible in life, are now expressed on the dorsolateral back.

Variation in the type series. Snout-urostyle length of 16 adult males varies from 19.8 to 22.8 mm, mean 21.4 mm (SD 0.97). Three adult females are 23.8, 24.0 and 25.1 mm long. One specimen of 15.9 mm SUL does not show signs of sexual maturity. There are no differences in coloration or body proportions between males and females, but almost all males can be recognised by their expanded throat skin. Body ratios vary as listed in Tables 1 and 2. Fingers are generally not webbed, webs on feet are in general most strongly expressed between toes 4 and 5 and

least of all between 1 and 2 (see Fig. 3). Small warts and pustules can be found on the whole dorsal surface, their number varies considerably. Tympanum is covered by skin and in many specimens only visible under certain lighting. Basic colour of dorsal side of head, trunk and extremities in life showed different hues of grey, yellow or brown covered by irregular smaller and larger dark brown or blackish spots. Basic colour changed into different hues of grey in preserved specimens. Eight specimens have a generally lighter dorsum, they have a whitish snout which is sharply bordered by a blackish spot. The border between the light snout and dark occiput passes between middle of the eyes (compare Fig. 1). All these lighter specimens have a clearly expressed w-shaped mark between the shoulders, a large whitish and more or less bent lumbar spot which partly encloses a black spot, and a small whitish spot in the middle of the shank. Two broad dark stripes commence at the w-shaped mark and, diverging posteriorly, pass to the inguinal region. These stripes are not always expressed in life but are visible in all preserved specimens. About half of the preserved frogs have rather dark dorsal surfaces, dark brown pigments covering the pattern shown above (Fig. 4). All frogs have a small blackish temporal spot from the posterior orbital opening to a short way behind the tympanum and all have whitish rings at the base of finger and toe tips and white spots on the discs. Grey ventral surface of throat, trunk and extremities is strongly mottled with dark brown.

Osteology (based on the cleared and double-stained paratype ZMB 62531 and the superficially dissected ZMB 62370): There are great similarities to the osteological features described for *Oreophryne atrigularis* (Günther et al. 2001) and these will not be repeated here. The following conspicuous differences exist

Tab. 1. Body proportions of the 16 males of the type series of *Oreophryne sibilans*. SD=Standard deviation, explanation of the other abbreviations in "Material and methods".

Ratio	Mean	SD	Range
TL/SUL	0.47	0.018	0.44-0.51
TaL/SUL	0.30	0.013	0.28-0.32
T4D/SUL	0.064	0.004	0.060-0.070
T4D/F3D	0.815	0.034	0.764-0.866
HL/SUL	0.284	0.015	0.267-0.316
HL/HW	0.812	0.046	0.730-0.887
END/IND	1.07	0.056	1.00-1.19
ED/SUL	0.118	0.005	0.112-0.125
TyD/ED	0.340	0.049	0.240-0.400
SL/SUL	0.133	0.004	0.122-0.140
GFD/SUL	0.29	0.012	0.27-0.31

Tab. 2. Body proportions of the 3 females of the type series of *Oreophryne sibilans*.

Ratio	Mean	Range
TL/SUL	0.45	0.44-0.47
TaL/SUL	0.29	0.28-0.29
T4D/SUL	0.064	0.058-0.071
T4D/F3D	0.809	0.777-0.850
HL/SUL	0.252	0.247-0.258
HL/HW	0.776	0.756-0.794
END/IND	1.11	1.11-1.12
ED/SUL	0.109	0.105-0.116
TyD/ED	0.375	0.357-0.400
SL/SUL	0.119	0.115-0.125
GFD/SUL	0.27	0.26-0.27



Fig. 1. Dorsolateral view of the holotype (ZMB 62587) of *Oreophryne sibilans*, spec. nov.



Fig. 2. Ventral view of the preserved holotype (ZMB 62587) of *Oreophryne sibilans*, spec. nov.

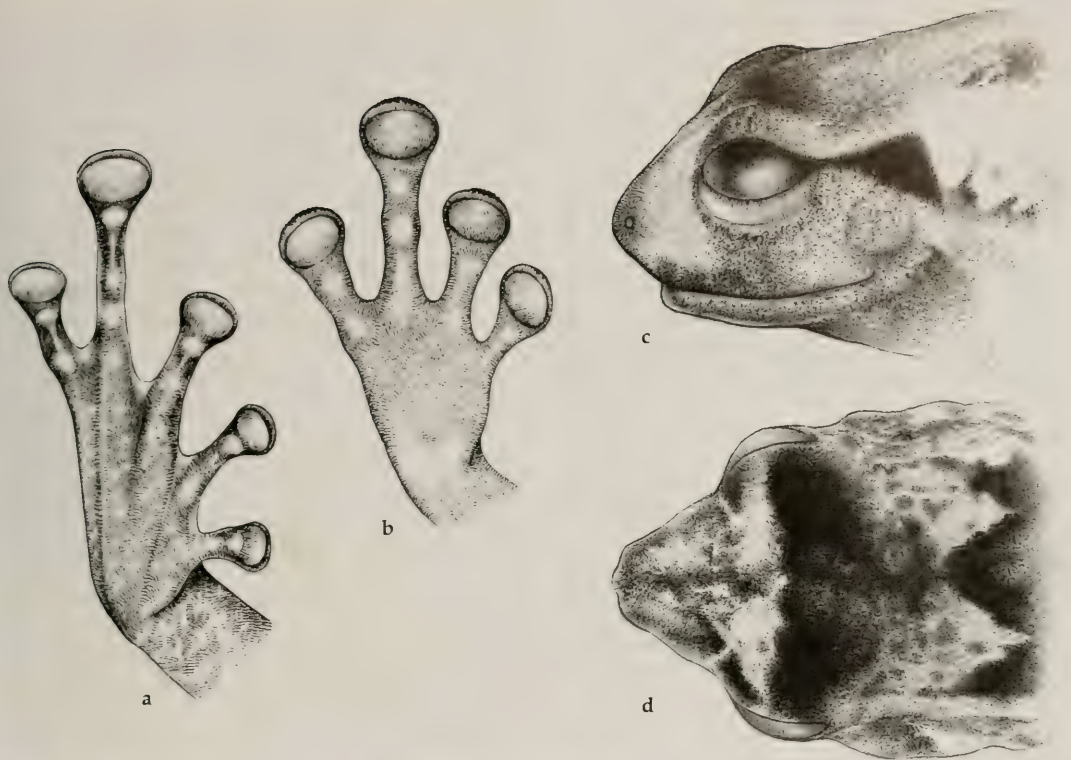


Fig. 3. Female paratype (ZMB 62586) of *Oreophryne sibilans*, spec. nov. a, foot in ventral view; b, hand in ventral view; c, head in dorsolateral view; d, head in dorsal view. Drawings by Nils Hoff.



Fig. 4. Dorsolateral view of a paratype of *Oreophryne sibilans* spec. nov. with darker dorsum.

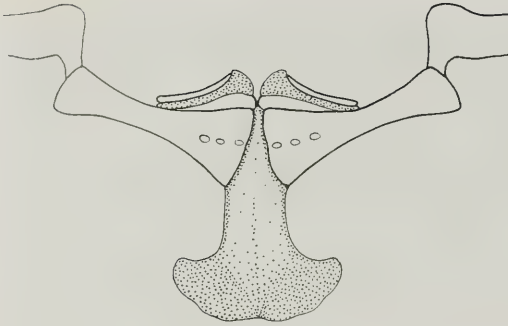


Fig. 5. Shoulder girdle of *Oreophryne sibilans* (ZMB 62531). White: bones; stippled: cartilage. Drawing by Vera Heinrich.

between *O. atrigularis* and *O. sibilans*: the former has broader diapophyses on all vertebrae (except the first which has no diapophyses at all in anurans), a smaller transversal process of the end-phalanx of the first finger, smaller cross-parts of the end-phalanx of all toes, smaller protuberances on the posteromedial processes of the hyoid apparatus, and a steeper angle between clavicles and coracoids; moreover, the sternum has clearly differentiated lateral lobes in *O. atrigularis* but these are more simply shaped in *O. sibilans* (compare Fig. 5 with Fig. 8 in Günther et al. 2001).

Etymology. The specific epithet “*sibilans*” is of Latin origin and means whistling. It refers to the whistling advertisement calls of this species.

Distribution: All type specimens were collected between 500 and 800 m a.s.l. on slopes and in valleys east of the main ridge of the Wondiwoi Mts. at the base of the Wandammen Peninsula. In May,

2000 several frogs were collected on Yapen Island, about 7 km north of the village Konti (NE of Serui) at an altitude of 630 m a.s.l., whose morphological traits and advertisement calls were similar to that of *O. sibilans*. However there are some differences in vocalization and further studies are needed to show whether the population from Yapen differs from that of the Wondiwoi Mts. to a taxonomically relevant degree. There is a similar situation with calls, recorded on May 2nd, 2000 in the Fakfak Mountains. These calls were similar to those of *O. sibilans*, suggesting that this species may also occur in the Fakfak Mts.

Habitat and habits. *O. sibilans* belongs to the more abundant amphibian species in the rainforests of the Wondiwoi Mts. at altitudes between 450 and 750 m a.s.l. west of the coastal village of Yeretuar. Specimens were mainly found on leaves of shrubs, sometimes on leaves of lower branches of trees, or on grasses. Perch heights were between 0.3 and 3.0 m, but most frogs were found between 1 and 2.5 m above the ground. Males were less territorial than those of *O. atrigularis*, in some cases two or even three individuals called from the same shrub. Minimum individual distances were about 0.5 m. Frogs were not found calling under leaf litter. Calling commonly started during dusk and lasted until dawn, but by far the highest activity levels were between shortly after dark and 10:00 p.m. and when the weather was moist. Calling activity was much less intense during windy and dry conditions or heavy rain.

Vocalization. Advertisement calls of *O. sibilans* consist of series of short and high pitched whistles or peeps. 51 calls of four different males were analyzed. Call duration was on average 3.17 seconds

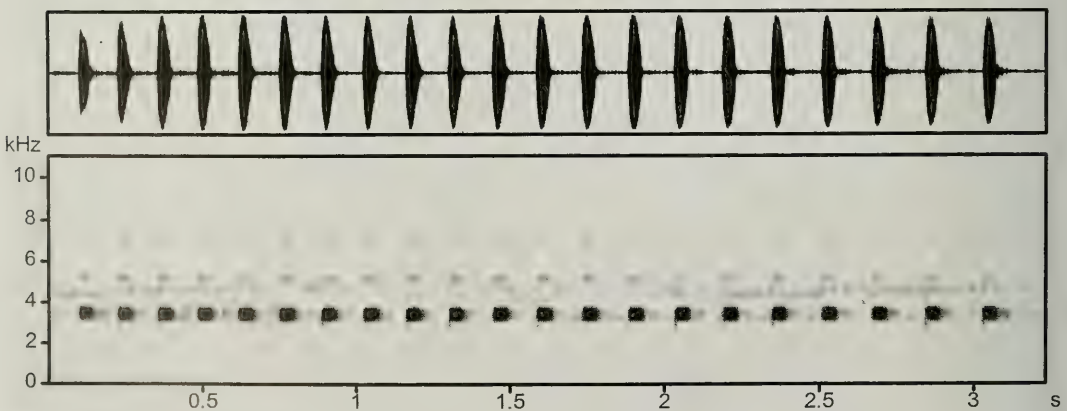


Fig. 6. Oscillogram (above) and audiospectrogram (below) of an advertisement call of *Oreophryne sibilans* consisting of 21 notes.

(SD 0.57, range 0.95–4.01 s). There was a mean of 21 notes per call (SD 3.45), minimum 6 and maximum 26 notes/call. Note duration of 367 notes was on average 47.1 milliseconds (SD 4.36), range 36–59 ms. Internote intervals, $n=349$, lasted on average 102.4 ms (SD 19.5), range 66–178 ms. Mean note repetition rate in 51 calls was 6.68 notes/s (SD 0.36), range 5.97–7.30 notes/s. While duration of notes within the calls hardly varied, internote intervals became longer during the second half of each call (Fig. 6). The interval between the last two notes was always the longest of all intervals and nearly twice as long as intervals at the beginning of the calls. Notes are unpulsed, there is a strong rise in amplitude at the beginning, a gradual decrease during the course and a rather sudden decrease of the amplitude at the end of the note. Fundamental frequency is about 1.6 kHz (scarcely visible in the audiospectrogram on Fig. 6, below), dominant frequency is clearly centered within a small range around 3.25 kHz. There are two more harmonic bands at 4.8 and 6.5 kHz. All calls were recorded at temperatures between 23 and 25 °C.

Comparison with other species. Within the genus *Oreophryne* all hitherto described species can, on the basis of the structure of their procoracoid, be differentiated into two groups. The procoracoid of one group is connected with the epicoracoid cartilage medially and with the base of the scapula laterally; in the species of the second group the cartilaginous procoracoid reaches laterally only to the middle of the coracoid bone and has no cartilaginous connection to the scapula. *O. sibilans* belongs to the second group and should be compared mainly with those species. With a snout-vent length of more than 40 mm *O. anthonyi* (Boulenger, 1897) and *O. inornata* Zweifel, 1956 are far larger than *O. sibilans* (largest female with 25.8 mm SUL). *O. brevicrus* Zweifel, 1956 is a ground-dwelling species of higher altitudes (above 2500 m a.s.l.) and has shorter legs as well as smaller finger and toe discs. *O. brachypus* (Werner, 1898) has also shorter limbs, different advertisement calls (Tyler 1967) and was found up to now only on islands of the Bismarck Archipelago. *O. wolterstorffi* (Werner, 1901) has more expanded webs, especially between toes 1 and 2 as well as 2 and 3, a light ventral surface, no whitish spots in the lumbar region and smaller discs on the fingers and toes. The holotype of *O. geislerorum* (Boettger, 1892) has shorter tibiae (TL/SUL 0.39), smaller discs on fingers and toes (T4D/SUL 0.0555; T4D/T3D 0.933) and in life a different coloration of the ventral surface; moreover a blackish spot behind the eye (present in *O. sibilans* and not visible in the bleached holotype now) was also not mentioned in the orig-

inal description. *O. insulana* Zweifel, 1956 has shorter tibiae (three specimens which I saw, have ratios TL/SUL 0.40, 0.42 and 0.43), a greater difference between the diameter of finger and toe discs (T4D/F3D 0.571, 0.600 and 0.692), a smaller internarial distance (END/IND 0.91, 0.95 and 1.04), larger eyes (ED/SUL 0.128, 0.137 and 0.142) and a greater distance between the glandular folds (GFD/SUL 0.31, 0.33 and 0.35). Moreover, there are differences in coloration, for example *O. insulana* has a whitish longitudinal vertebral line; none of the specimens of *O. sibilans* has such a line. Some problems of an exact assessment of *O. biroi* were mentioned in a previous paper (Günther et al. 2001). According to J. Menzies (1975 and pers. com. in August 2001) *O. biroi* Mehely, 1897 and *O. loriae* (Boulenger, 1898) have lighter ventral surfaces and rattling advertisement calls. *O. parkeri* Loveridge, 1955 can be recognised by its completely white tibiae and its very distinct tympanum. According to morphological traits *O. albopunctata* (van Kampen, 1909) seems to be most closely related to *O. sibilans*. Differences between these species are a shorter tibia (TL/SUL 0.40 and 0.43 in the syntypes) and a shorter tarsus (TaL/SUL 0.27 and 0.27 in the syntypes) in *O. albopunctata*, and furthermore a less protruding snout, a broader snout tip, a longer 3rd toe in comparison to the 5th toe and a lighter ventral surface in the latter. The most obvious differences between the new species and both *O. atrigularis* and *O. wapoga* are to be found in vocalisation and coloration (see Günther et al. 2001).

Oreophryne unicolor, spec. nov.

Figs 7-12

Types. Holotype: adult ♂, collected by R. Günther on 27.VIII.1999 at an altitude of 600 m a.s.l., Wondiwoi Mts. at the base of the Wandammen Peninsula, about 8 km west of the coastal village of Yeretuar, 2°56'S, 134°37'E, Papua, Indonesia (ZMB 62231). – Paratypes: 1 adult ♂, collected by M. Kapisa on 27.VIII.1999 in about 100 m distance from the holotype locality (ZMB 62232), 1 sub-adult ♀, collected by R. Günther and M. Kapisa at the beginning of May, 2000 in 800 m a.s.l. about 3 km west of the locus typicus (ZMB 65131).

Diagnosis. A medium sized *Oreophryne* (males up to at least 29 mm SUL) whose procoracoid does not extend to the scapula laterally. Snout not protruding, canthus rostralis roundish. Finger discs broader than toe discs, basal webbing between toes, tympanum invisible. Coloration uniform greenish or brownish. Advertisement call consist of a series of 5–10 long, whistling notes, each note with a duration of 149–194 ms, note repetition rate is 1.7/s.

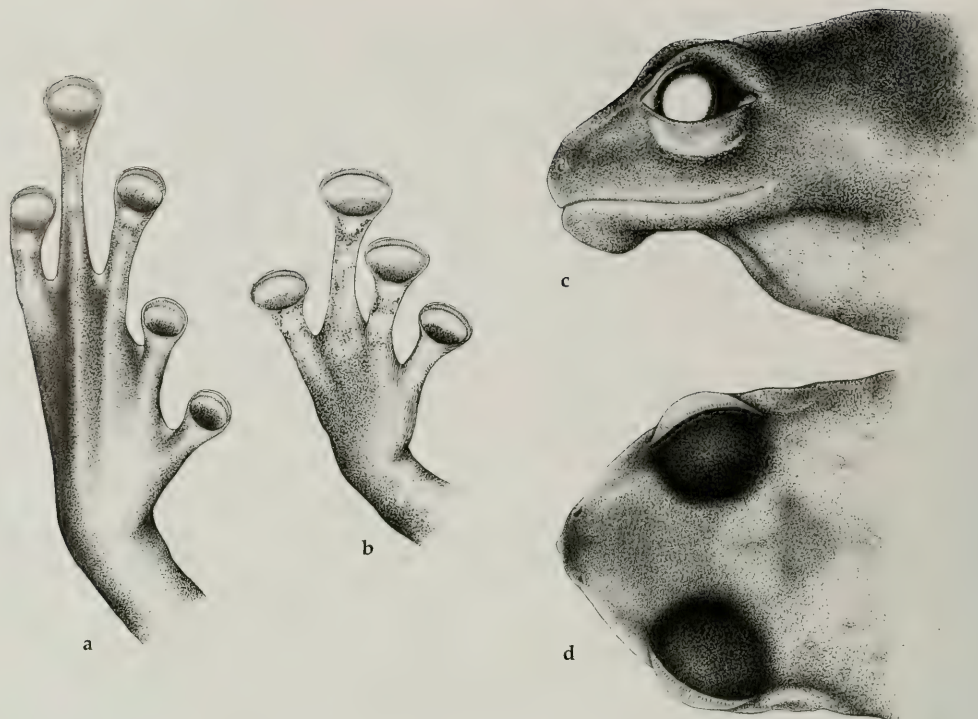


Fig. 7. Holotype of *Oreophryne unicolor*, spec. nov. (ZMB 62231). **a**, foot in ventral view; **b**, hand in ventral view; **c**, head in lateral view; **d**, head in dorsal view. Drawings by Nils Hoff.



Fig. 8. Holotype of *Oreophryne unicolor*, spec. nov. in life.



Fig. 9. Ventral view of *Oreophryne unicolor* spec. nov., preserved paratype ZMB 62232. The ventral surface of the holotype has a very similar coloration.



Fig. 10. Rainforest habitat in the Wondiwoi Mountains, 560 m a.s.l., where *O. unicolor* and *O. sibilans* were found syntopically.

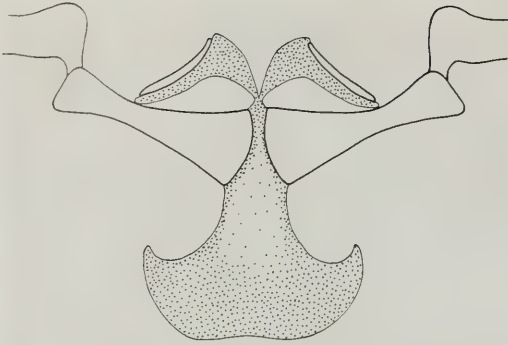


Fig. 11. Shoulder girdle of *Oreophryne unicolor* (ZMB 62232). Drawing by Vera Heinrich.

Description of holotype

An adult male (Figs 7 and 8) whose measurements and ratios are given in Table 3. Snout roundish with a straight and roundish canthus rostralis, tongue very large, not forked and half free behind, a slightly bent denticulated prepharyngeal ridge; no ridge and no denticles on the palatine bones, no vomerine teeth, short vocal sac slits near the mouth angles, a single subgular vocal sac; head clearly broader than long with big eyes; tympanum near the eye and very indistinct, fingers with large discs, that of the 3rd finger broader than half orbital opening, length of fingers $3 > 2 = 4 > 1$. Toe tips smaller than finger tips, webbing between 3 and 4 as well as between 4 and 5 more expressed than between 1 and 2 or 2 and 3. A slightly visible inner and no outer metatarsal tubercle, some feebly developed subarticular tubercles. Length of toes $4 > 3 = 5 > 2 > 1$. Supratympanic fold weakly expressed, skin smooth everywhere with some minute pustules on dorsal surface and on throat. Colour of dorsal surface of body, extremities and head was uniformly greenish in life (see Fig. 8), grey in ethanol; most of the very small whitish dots (tips of pustules) on these body parts, seen in life, disappeared in fixative; throat brownish, abdomen whitish; superior part of iris golden, inferior part of iris dark brown.

Variation in the type series. There are two paratypes, an adult male (ZMB 62232) and a subadult female (ZMB 65131), whose measurements and ratios are listed in Table 3. The male paratype has also an uniform dorsal colour, but in life it was brownish-grey instead of greenish. Its ventral surface (Fig. 9) was as light as in the holotype. The subadult female has minute ovaries and is more strongly pigmented than both of the other type specimens. Its flanks are darker anteriorly than posteriorly, its ventral surface is mottled and anterior and posterior surfaces

of the thighs are light with some small spots. I collected a third adult male of this new species on 11 May 2000 at an altitude of 800 m a.s.l. It was of the same size as the other two males and also had an uniform coloration (grey-brown). Unfortunately this specimen escaped before photographs could be taken. None of the specimens showed larger blackish and/or whitish spots on the dorsal surface as is the case in most *Oreophryne* species.

Osteology. Radiographs and a superficial dissection of the ventral elements of the pectoral girdle followed by cartilage staining with alcyan blue in one paratype revealed that the procoracoid has no cartilaginous connection to the scapula and that the angle between the clavicle and coracoid is steeper than in *O. sibilans* (Fig. 11). Further details must be studied if more material becomes available.

Etymology. The Latin adjective "unicolor" means unicoloured and refers to the fact that the whole dorsal side of body, head and extremities has a homogenous colour without larger spots.

Tab. 3. Biometrical values of the holotype and two paratypes of *Oreophryne unicolor*, all measurements in mm.

	Holotype ZMB 62231	Paratype ZMB 62232	Paratype ZMB 65131
SUL	28.5	29.0	23.6
TL	11.6	11.4	10.2
TaL	7.4	7.5	6.7
T4L	11.5	11.6	10.1
T4D	2.0	1.9	1.6
F3L	7.7	7.2	6.5
F3D	2.2	2.2	1.8
HL	8.8	8.4	7.3
HW	10.4	10.2	8.3
END	2.8	2.8	2.1
IND	2.2	2.5	1.9
ED	3.8	3.7	2.7
TyD	0.8		
SL	4.0	3.7	3.0
TIL	2.6	2.4	2.1
MTL	1.3	1.1	0.8
GFD	8.9	9.0	7.2
TL/SUL	0.41	0.39	0.43
TaL/SUL	0.26	0.26	0.28
T4D/SUL	0.070	0.065	0.067
T4D/F3D	0.909	0.863	0.888
HL/SUL	0.308	0.289	0.309
HL/HW	0.846	0.823	0.879
END/IND	1.27	1.12	1.11
ED/SUL	0.133	0.128	0.114
TyD/ED	0.216		
SL/SUL	0.140	0.127	0.127
GFD/SUL	0.31	0.31	0.31

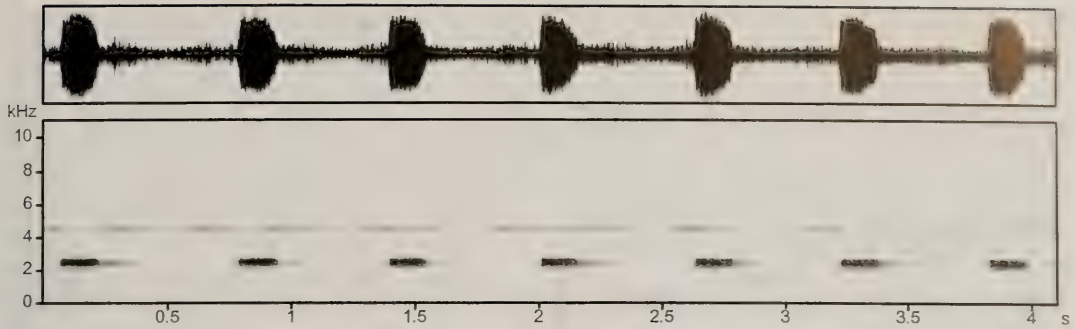


Fig. 12. Oscillogram (above) and audiospectrogram (below) of an advertisement call of *Oreophryne unicolor* consisting of 7 notes.

Distribution. *O. unicolor* was found from 500 to 900 m a.s.l. on slopes and in valleys east of the main ridge of the Wondiwoi Mts. at the base of the Wandammen Peninsula. Moreover, we recorded calls in the Fakfak Mountains in May, 2000 which were very similar to those of *O. unicolor*, suggesting that this species may also live in this area.

Habitat and habits. The new species is an inhabitant of rainforests where the trees are less densely standing (Fig. 10). Despite their loud calls and their occurrence in a large area, specimens were difficult to find. This is due mainly to two reasons, (1) most calling males are living on trees and bushes at heights of 3–6 m above ground, (2) calls have a certain quality which makes it difficult to locate them. One male was found on a shrub 1 m above the ground, and two males were perching on leaves of shrubs at heights of 1.80 m and 2 m respectively. One of these males was clinging to a vertical green leaf. A dry leaf was situated in a horizontal position like a “roof” above its head. Through this special arrangement of the leaves the calls of the frog could possibly be directed and reach a further distance. It would be interesting to learn whether this calling site was actively chosen by the male or was only accidental. Most calling males were at least 10 m apart, so individual distances are much higher in this species than in other *Oreophryne* species living on the Wondiwoi Mts. Calling activity was most intensive in the early evening hours. *O. unicolor* and *O. sibilans* occur syntopically from 500 to 750 m a.s.l.

Vocalization. As in *O. sibilans*, advertisement calls of *O. unicolor* consist of series of monotonous high pitched whistles or peeps. The whistles and intervals between them are much longer in the latter

species (Fig. 12). 14 calls of 3 different males could be analysed. Mean call duration was 4.6 s (SD 0.88), range 2.78–5.87 s. Mean number of notes per call was 7.64 (SD 1.5), range 5–10 notes/call. Mean note length of 66 notes was 167.4 ms (SD 10.64), minimum 149 ms and maximum 194 ms. Mean internote interval duration of 58 intervals was 485.6 ms (SD 66.14), range 405–730 ms. Note repetition rate in 14 calls varied between 1.49 and 1.80 notes/s, mean repetition rate 1.68 notes/s. There is no modulation of intensity of sound during most parts of the notes and tone frequency is restricted to a small range (Fig. 12, below). The oscillogram of a call with seven notes (Fig. 12, above) shows that the increase of amplitude in every note is steeper than the decrease. The oscillogram of a dilated note has, however, rather spindle-like outlines. Dominant frequency is focused around 2.5 kHz, no harmonics could be detected. All calls were recorded at temperatures between 22 °C and 24 °C.

Comparison with other species. Males of most hitherto known *Oreophryne* species have a SUL of less than 25 mm and are easy to distinguish from the larger *O. unicolor* by this trait. *O. anthonyi* is larger than *O. unicolor* and has a different colour pattern. The greatest similarities in size and colour (including structure of the pectoral girdle) seem to exist with *O. inornata* from the Goodenough Island (D’Entrecasteaux Islands) near eastern tip of New Guinea. According to Zweifel (1956) *O. inornata* has toe discs as wide as finger discs (in *O. unicolor* finger discs are clearly broader than toe discs) and the fifth toe longer than third (this tendency is the reverse in *O. unicolor*). The ratio TL/SUL is obviously lower in *O. unicolor*.



Fig. 13. Dorsolateral view of the living holotype of *Oreophryne clamata*, spec. nov. (ZMB 62588).

Oreophryne clamata, spec. nov.

Figs 13-18

Types. Holotype: adult ♂ (Fig. 13), collected by R. Günther and G. Mareku on 9.V.2000 at an altitude of 860 m a.s.l., Wondiwoi Ms. at the base of the Wandammen Peninsula, 2°56'S, 134°36'E, Papua, Indonesia (ZMB 62588). – Paratypes: 4♂♂, collected on 4.VIII.1999 (ZMB 62326-28) and 9.V. 2000 (ZMB 62652); 1♂, collected on 24.VIII.1999, was cleared and stained as a skeletal preparation (ZMB 62530). All paratypes were collected by R. Günther, S. Marani, and G. Mareku on and near the main ridge of the Wondiwoi Mts. (800-900 m a.s.l.) west of the coastal village of Yeretuar.

Diagnosis. With a snout-urostyle length of less than 21 mm in males, *O. clamata* is one of the smallest known species of the genus. Its procoracoid is connected with the scapula by a cartilaginous bridge. Fifth toe equally or slightly longer than third, no webs between toes. Snout short and blunt, skin warty, tympanum scarcely visible. Advertisement calls are loud rattles of 0.9-1.4 s duration, the notes contain 4-7 pulses and have a mean length of 22 ms, note repetition rate is 17.3/s.

Description of holotype

Various measurements and ratios of the holotype are listed in table 4. Snout short and blunt and slightly pointed in front of the nostrils. Canthus rostralis immediately in front of the eye sharp edged and straight, anteriorly becoming roundish and feebly bent, loreal region high and oblique and weakly concave, eye large, its horizontal diameter wider than the distance between anterior edge of orbital opening and snout tip. Tongue rather narrow, without indentation and about half free posteriorly, one row of small skin lappets in front of the pharynx, palatine slightly raised, no vomerine teeth, a long slit on each side of the tongue indicate the entrance to a single subgular vocal sac. Head conspicuously broader than long, tympanum small and very indistinct. Fingers with broad truncate discs, their relative length $3 > 4 = 2 > 1$, no webs. Semicircular toe discs clearly smaller than finger discs, relative length of toes $4 > 5 = 3 > 2 > 1$, also without webs. Tibia shorter than half snout-urostyle length, subarticular tubercles as well as metatarsal tubercle weakly developed. Supratympanic fold short and barely visible, skin on the whole dorsal and ventral surface covered with numerous warts and pustules, these were more emphasised when the frog was alive. Colour of the dorsal surface in life was yellowish from eye



Fig. 14. View of the throat and anterior belly of a paratype of *Oreophryne clamata*, spec. nov. Coloration is much like that of the holotype.

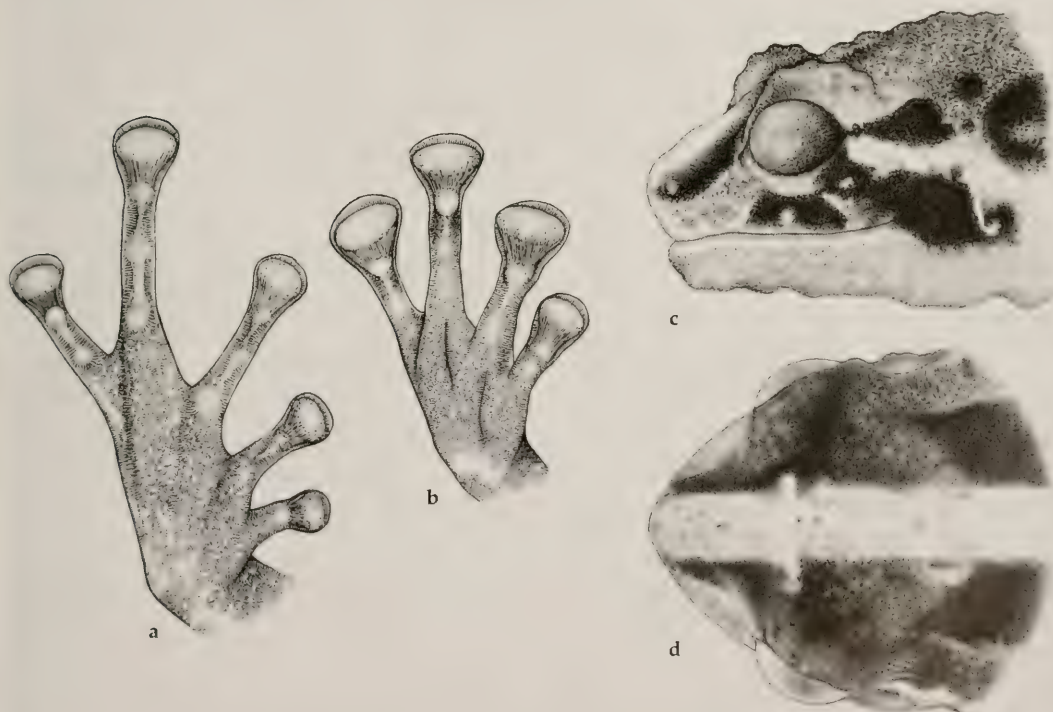


Fig. 15. Paratype (ZMB 62327) of *Oreophryne clamata*, spec. nov., with a broad whitish middorsal stripe. a, foot in ventral view; b, hand in ventral view; c, head in lateral view; d, head in dorsal view. Drawings by Nils Hoff.



Fig. 16. Shoulder girdle of *Oreophryne clamata* (ZMB 62538). Drawing by Vera Heinrich.

through flank, in the lumbar region, on the anterior half of the head and on both sides of the elbow. A brownish colour dominates the dorsal surface of all legs and the dorsum. Conspicuous black spots were present behind the eye (temporal streak), around insertion of arms, around the yellowish lumbar spot and on the forearm. Hands and feet including fin-

Tab. 4. Biometrical values of the type series of *Oreophryne clamata*, all measurements in mm; ZMB 62588 is the holotype.

ZMB-No.	62326	62327	62328	62652	62588
SUL	18.5	19.6	20.4	19.8	19.5
TL	9.2	9.1	9.5	8.9	9.3
TaL	6.6	6.2	6.5	6.2	5.9
T4L	8.7	7.9	8.6	8.3	8.2
T4D	0.9	0.8	0.8	0.8	0.8
F3L	5.9	5.5	6.2	5.0	5.5
F3D	1.4	1.3	1.2	1.2	1.3
HL	5.6	5.9	6.3	5.5	5.6
HW	7.7	7.2	7.8	7.8	8.0
END	1.7	1.9	1.8	1.6	1.7
IND	1.9	2.0	2.0	1.8	2.0
ED	2.6	2.5	3.0	2.6	2.8
TyD	0.6?	0.6	0.6	?	?
SL	2.9	2.8	2.8	2.9	3.1
T1L	2.0	?	2.0	?	?
MTL	1.0	?	1.2	?	?
GFD	6.4	6.0	6.5	6.3	6.4
TL/SUL	0.50	0.46	0.47	0.45	0.48
TaL/SUL	0.36	0.32	0.32	0.31	0.30
T4D/SUL	0.048	0.040	0.039	0.040	0.041
T4D/F3D	0.642	0.615	0.666	0.666	0.615
HL/SUL	0.302	0.301	0.308	0.277	0.287
HL/HW	0.727	0.819	0.807	0.705	0.700
END/IND	0.89	0.95	0.90	0.89	0.85
ED/SUL	0.140	0.127	0.151	0.131	0.143
TyD/ED	0.230	0.240	0.200	?	0.250
SL/SUL	0.156	0.142	0.137	0.146	0.158
GFD/SUL	0.35	0.31	0.32	0.32	0.33

gers and toes spotted. Roundish iris golden and with many veins in the upper half, blackish in the lower half. All colours, except the black, faded and turned into various tones of grey in the preserved animal. Ventral surface grey and intensively mottled with dark brown (Fig. 14).

Variation in the type series. Snout-urostyle length of 6 adult males varies from 18.5 to 20.4 mm (mean 19.7 mm, SD 0.67). Mean values of various ratios of 5 specimens are as follows: TL/SUL 0.47 (SD 0.019), TaL/SUL 0.32 (SD 0.023), T4D/SUL 0.0420 (SD 0.0037), T4D/F3D 0.61 (SD 0.026), HL/SUL 0.295 (SD 0.013), HL/HW 0.752 (SD 0.057), END/IND 0.90 (SD 0.036), ED/SUL 0.138 (SD 0.0096), TyD/ED 0.23 (SD 0.022), SL/SUL 0.148 (SD 0.0090) and GFD/SUL 0.33 (SD 0.015). While body shape and measurements vary only slightly, there is a greater variability in colour pattern. Most obvious in two specimens is a broad whitish vertebral stripe from tip of snout to end of urostyle (Fig. 15). In two other specimens middle of dorsum posteriorly of the shoulder region is somewhat lighter than the dorsolateral region. Ground colour of the dorsum of most specimens was yellowish-brown in life but shows various tones of grey in fixative. Invariably a small whitish crossbar between the eyes, a black temporal streak bordered with white below, some black spots above insertion of arms, one black spot on the forearm and one white spot in the lumbar region is present. The whitish streak, bordering the black temporal streak inferiorly, passes downwards into a silvery and slightly raised glandular fold. Dorsal surface of extremities light to dark brown with a few small lighter and darker spots. Fingers and toes in all specimens spotted and marbled with white. Belly and throat homogeneously grey and densely marbled with dark brown. Lower lip is only in one other specimen as regularly spotted with white as in the holotype.

Osteology (based on the cleared and double stained paratype ZMB 62538 and the superficially dissected and cartilage-stained ZMB 62652). Shape of most bones is similar to that of *O. atrigularis* and *O. sibilans*. The following differences between *O. clamata* and *O. sibilans* were detected: frontoparietalia narrower transversally in *O. clamata*; zygomatic ramus of squamosal distinctly marked in *O. clamata* but hardly developed in *O. sibilans*; parasphenoid with a long extended and pointed pars medialis in the former but with a shorter and blunt pars medialis in the latter; broader and longer diapophyses in the vertebrae 2 and 4 in *O. clamata*; a small sesamoid bone at the distal end of the humerus only in *O. clamata*; distal end of clavícula more bent in *O. clamata*; cartilaginous connection between epic-

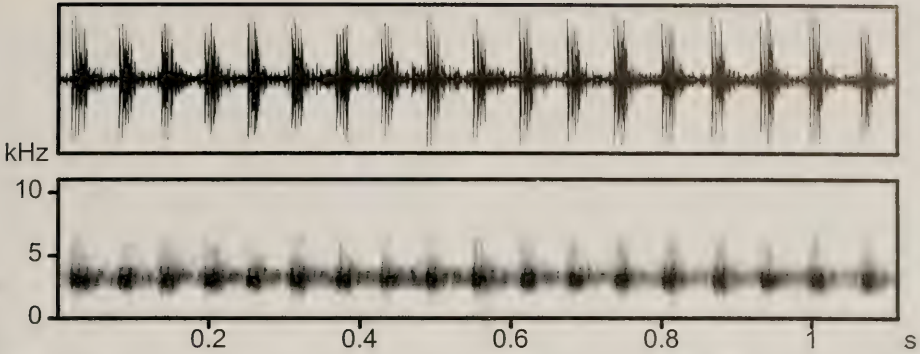


Fig. 17. Oscillogram (above) and audiospectrogram (below) of an advertisement call of *Oreophryne clamata* consisting of 18 notes.

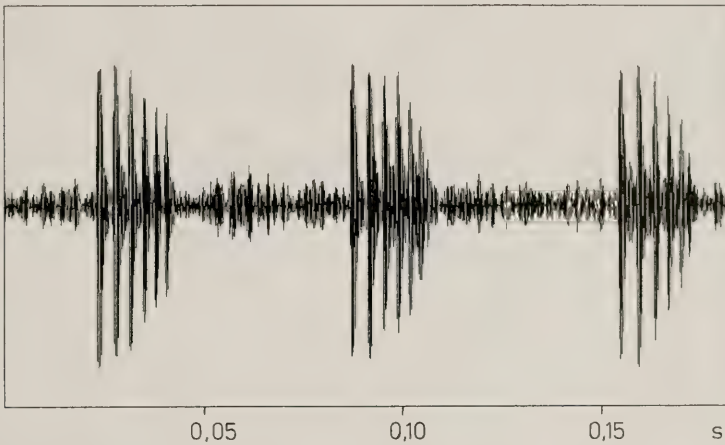


Fig. 18. Oscillogram of three (time expanded) notes of *Oreophryne clamata*.

oracoid cartilage and scapula via procoracoid in *O. clamata* (Fig. 16), scapula not connected in *O. sibilans* (Fig. 5); lateral lobes of sternum with long tips only in *O. clamata*; distal ends of coracoids thicken gradually in *O. sibilans* and thicken suddenly in *O. clamata*; anterior ramus of posterolateral process of the hyoid plate much longer than posterior ramus in *O. clamata*, only slightly longer in *O. sibilans* and posteromedial process longer and with only minor protuberances in *O. clamata*.

Etymology. The word “clamata” is of Latin origin and means “makes a loud noise”. It refers to the fact that the advertisement calls of this species are very striking.

Distribution. Found on the crest of the Wondiwoi Mts. and adjacent eastern slopes (western slopes were not visited) down to 750 m a.s.l. at the base of the Wandammen Peninsula.

Habitat and habits. Most frogs were found perching on smaller leaves of bushes and lower twigs of trees between 1 and 3 m above ground. These bushes and trees grew in rainforest with patchy very dense undergrowth. Because of their small size and their preference for perching on half-curved leaves, frogs were difficult to locate. In general, males stimulated one another to utter their loud calls, so that only seldom could a single specimen be heard. Often *Albericus laurini* (Günther 2000), another small microhylid frog, used exactly the same microhabitat as *O. clamata* and groups of both species were calling together. Shortest inter-individual distances were a few meters and calling groups resided at greater distances from one another. Frogs started calling shortly after dark and were heard until 10:00 p.m. Their habitats were never visited later at night or in the early morning. *O. clamata* lives syntopically with *O. unicolor* but there is no (or only a slight) overlap with *O. sibilans* and *O. atrigularis*.

Vocalization. 32 advertisement calls from 4 different males in the Wondiwoi Mts. were analysed. The very loud rattling calls have a length of 0.58-1.41 s, mean duration 0.96 s (SD 0.18). Mean number of notes per call was 16.7 (SD 3.18), min. 10 and max. 23 notes/call. Mean length of 233 notes was 22.1 ms (SD 4.26), range 15-34 ms. 217 internote intervals lasted from 26 to 56 ms, mean 38.7 ms (SD 4.89). Note repetition rate was from 16.3 to 18.4 notes/s, mean 17.3 notes/s (SD 0.59). There was no clear tendency for an increase or decrease in note length during the calls, but duration of internote intervals showed a tendency to become longer during the course of calls. The first note already has a maximum volume of sound which only slightly altered in the following notes (Fig. 17, above). Notes are composed of 4-7 pulses, often of a decreasing amplitude (Fig. 18). The single pulses are hardly visible on audiospectrograms (Fig. 17, below) but clearly expressed in oscillograms of time dilated notes (Fig. 18). The dominant frequency band is rather broad (especially in comparison to that of *O. sibilans* and *O. unicolor*), ranging from about 2.7 to 3.6 kHz and centred at 3.3 kHz. Temperature during recording was between 20 °C and 22 °C.

Comparison with other species. *O. clamata* belongs to a group of Papuan *Oreophryne* that have a cartilaginous connection between the procoracoid and scapula. These include: *O. crucifer* (van Kampen, 1913), *O. flava* Parker, 1934, *O. idenburgensis* Zweifel, 1956, *O. kampeni* Parker, 1934 and *O. moluccensis* (Peters & Doria, 1878). *O. kampeni* differs by its webbed feet, 5th toe clearly shorter than 3rd and a smooth dorsum. *O. idenburgensis* is a much larger species (up to 45 mm SUL). *O. crucifer* is also larger than *O. clamata*, the male syntype ZMA 5819 has a SUL of 23.6 mm. Moreover it differs in various ratios: T4D/SUL 0.0677 (0.0392-0.0486 in *O. clamata*); T4D/F3D 0.842 (0.615-0.666 in *O. clamata*); END/IND 1.25 (0.85-0.95 in *O. clamata*). *O. moluccensis*, from which I studied the lectotype of its synonym (according to Parker, 1934) *O. senckenbergiana*, SMF 4203, can become larger (up to 26 mm SUL), has a smooth dorsum, webbed feet, broader toe discs in relation to finger discs (T4D/F3D 0.941), a longer head (ratio HL/HW 0.950, in *O. clamata* 0.700-0.819) and some differences in coloration. Greatest morphological similarities seem to exist between the new species and *O. flava*. A comparison of the holotype of *O. flava* (ZMA 5823) as well as 5 other specimens of that species deposited in AMNH, with the new species revealed the following differences: *O. flava* has shorter tibiae (TL/SUL in *O. flava* 0.43-0.45, in *O. clamata* 0.45-0.50), a longer head (HL/SUL 0.318-0.341 in *O. flava*, 0.277-0.302 in *O. clama-*

ta), longer 4th toes (length of 4th toe /SUL 0.38 in the holotype of *O. flava*, 0.40-0.47 in *O. clamata*), longer arms (ratio Arm length from elbow to tip of 4th finger/SUL is 0.48 in the holotype of *O. flava*, but 0.51-0.58 in *O. clamata*), a distinct tympanum and only indistinct tubercles on dorsal surface in *O. flava*. Moreover, the ventral surface of *O. flava* is described as "yellowish-white" by Parker (1934), it is strongly mottled with brown in *O. clamata*.

Common names

The following common names are proposed for the species described in this article:

O. sibilans should be called Whistling Cross Frog in English and Pfeifbergkröte in German;

O. unicolor should be called Unicoloured Cross Frog and Einfarbbergkröte respectively and

O. clamata should be called Noisy Cross Frog and Lärmbergkröte respectively.

As common names for two earlier described *Oreophryne* species (Günther et al. 2001) are proposed:

Black-Throated Cross Frog and Schwarzkehlbergkröte for *O. atrigularis*,

Wapoga Cross Toad and Wapogabergkröte for *O. wapoga*.

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